conoptics INC.

2011

User's Guide

LASS- II RM (Laser Amplitude Stabilization System)

Models 370, 350-105, 360-80 series

Warranty Information

ConOptics, Inc. guarantees its products to be free of defects in materials and workmanship for one year from the date of purchase.

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Introduction

ConOptics, Inc. manufactures an extensive line of low voltage electro-optic light modulators, drive electronics, and associated components to satisfy your diverse requirements.

Theory of operation

The LASS-IIRM (Laser Amplitude Stabilization System) is an electro-optic feedback loop designed to improve the signal/noise ratio of most visible and near IR laser. The system features a selectable reference (Internal/External) to allow remote programming of the stabilized output intensity.

In operation, the system compares an appropriate reference voltage to a sample of the detected laser output. This differential signal is then amplified via a high gain, high voltage amplifier and delivered to the E.O head 180° out of phase with the detected sample. The amplifier will then attempt to make the detected signal equal to the reference voltage within certain gain and phase restrictions. The internal reference is provided by a temperature compensated Zener diode and a ten turn precision potentiometer with a counting dial. Externally, the reference is provided by the end-user system (0 to +10V into 1K) and should be noise free and stable.

LASS II RM Product Specifications

Operating Conditions	514nm, laser power -50mw, lo-.5imax., Beam dia 1.4mm ($1/e^2$) TEM00
Noise Reduction (f.)	1/1 @ 300kHz (Int. Ref. Mode) 3/1 @ 100kHz 18/1 @ 50kHz 100/1 @ 10kHz 200/1 @ 1kHz 250/1 @ 200Hz
Noise Floor	458nm – 100db Relative to F.S.
D.C. Stability Short Term	.1% Relative to Full Scale (@.5 Imax), T=0 -> 1hr.
Ext. Modulation Bandwidth	(-3db), DC ->50kHz (.2 -> .8 Imax)
Ext. Input Impedance	10k nom
Ext. Input Voltage	0 -> +10V Max
Electrical Input Power	20W (100-230 VAC)
Optical Sensitivity	(The amount of light required to calibrate feedback loop) Output of beam splitter to diode @633nm – 300uw @514nm – 450uw @488nm – 540uw @458nm – 820uw Two different types of beam-splitters are available so as to optimize both efficiency and finesse
Static Transmission	85% (excluding beam-splitter)
Useable Aperture	2.5mm square (3.5mm Large Aperture also available)
Optical Bandwidth	400-800nm (UV and IR available on special order)
Maximum Throughput Power	3.5w/mm^2 TEM00

Front Panel Controls

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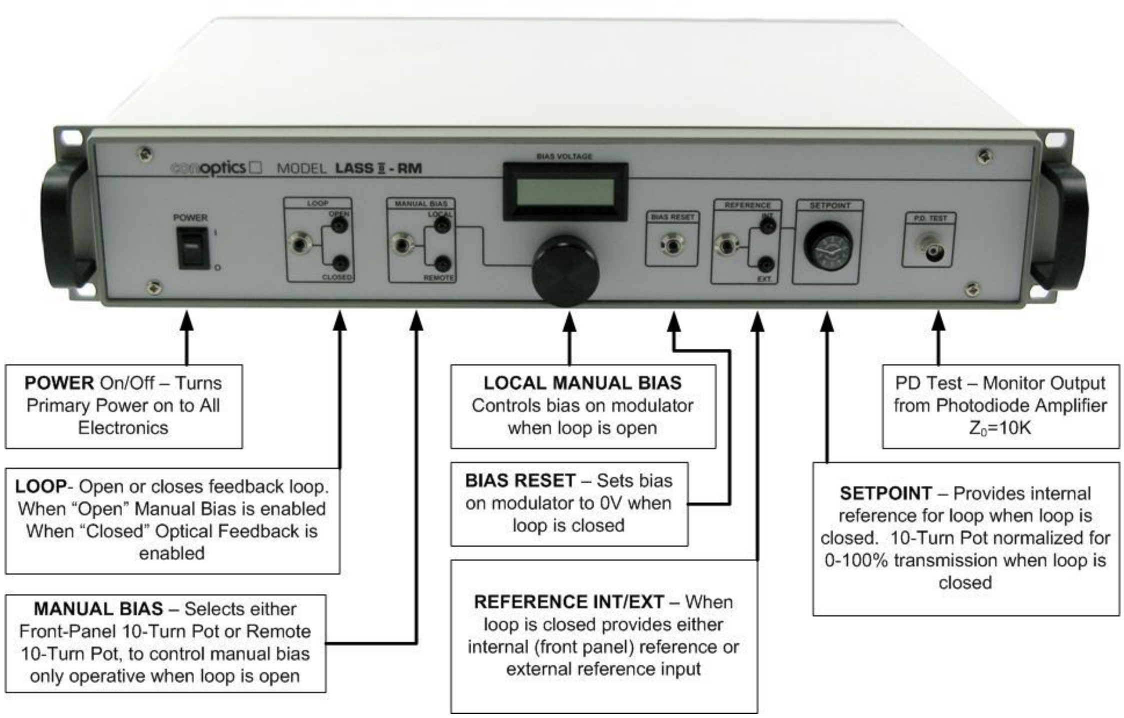
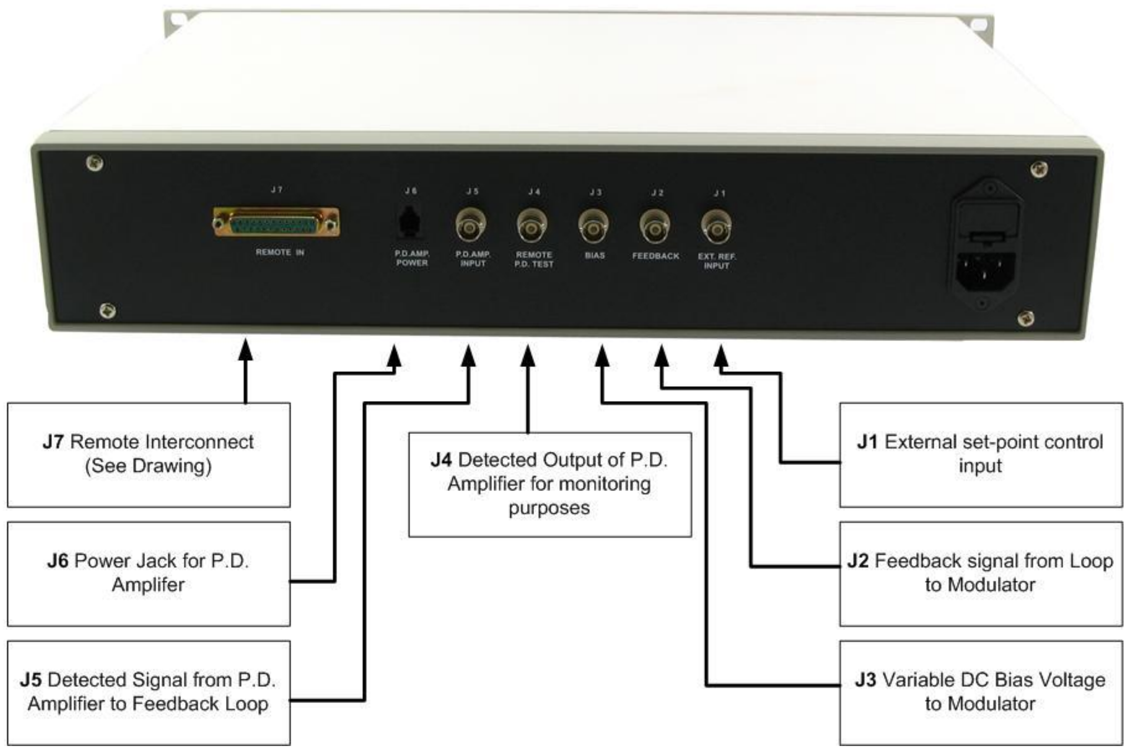


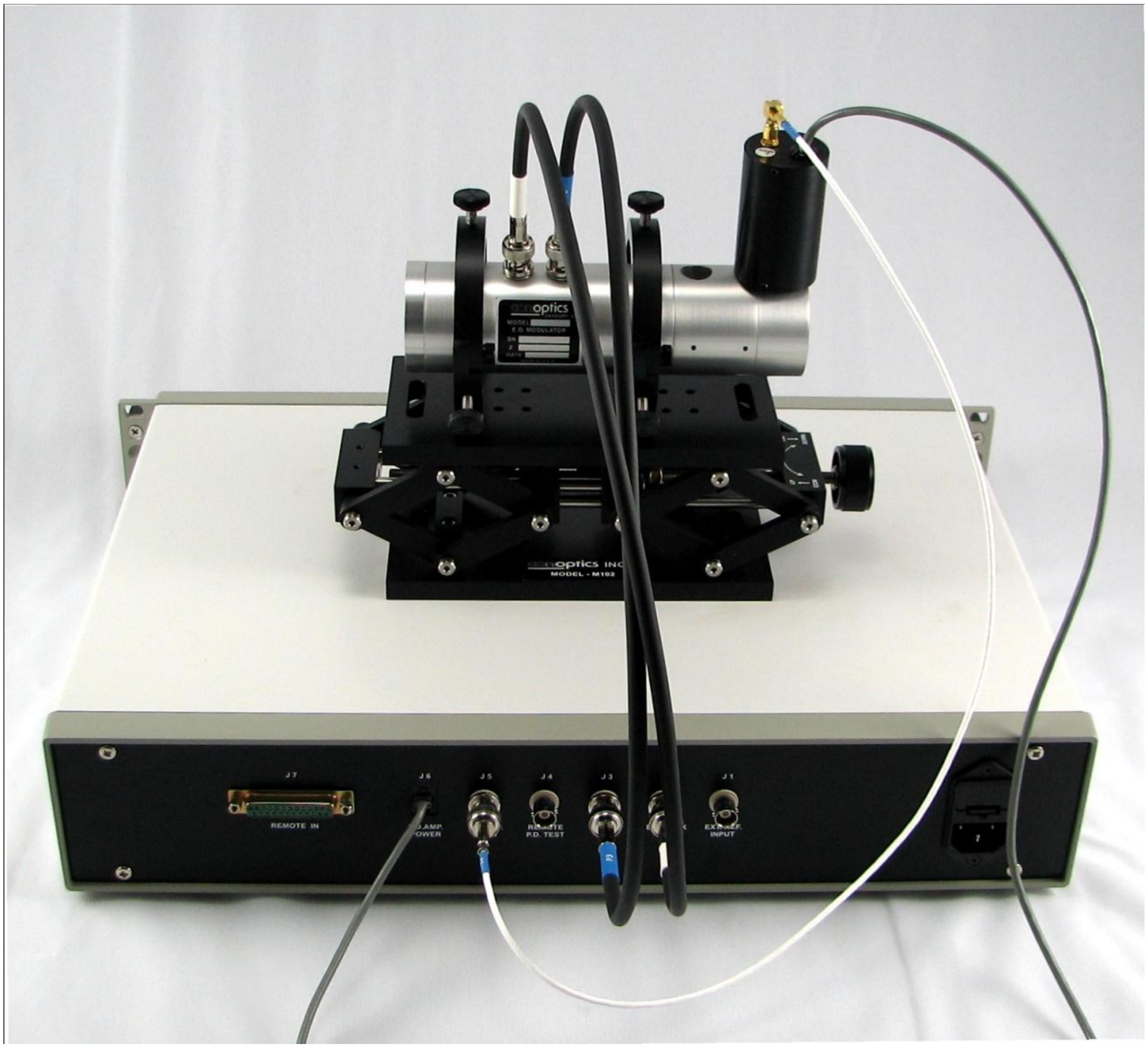
LASS-II-RM FRONT PANEL	
Power	On/Off – Turns Primary Power on to all electronics
Loop	Open or closes feedback loop. When "Open" – Manual Bias is enabled. When "Closed" Optical Feedback is enabled
Manual Bias	Selects either Front-Panel 10-Turn Pot,or, remote 10 turn pot to control manual bias. Only operative when loop is open
Local Manual Bias	Controls bias on modulator when loop is open
BIAS Reset	Sets bias on modulator to 0V when loop is closed
Reference INTERNAL / EXTERNAL	When loop is closed provides either Internal (Front-Panel) reference or external reference input
PD Test	Monitor Output from Photodiode Amplifier Z_0 = 10K
SETPOINT	Provides internal reference for loop when loop is closed. 10-Turn Pot normalized for 0-100% transmission when loop is closed

Rear Panel Controls



LASS-II-RM REAR PANEL	
J7	Remote Interconnect (detailed in the appendix)
J6	Power Jack for P.D. Amplifier
J5	Detected Signal from P.D. Amplifier to Feedback Loop
J4	Detected Output of P.D. Amplifier for monitoring purposes
J3	Variable DC Bias Voltage to Modulator
J2	Feedback Signal from Loop to Modulator
J1	External Set-Point Control Input

Connection Diagram



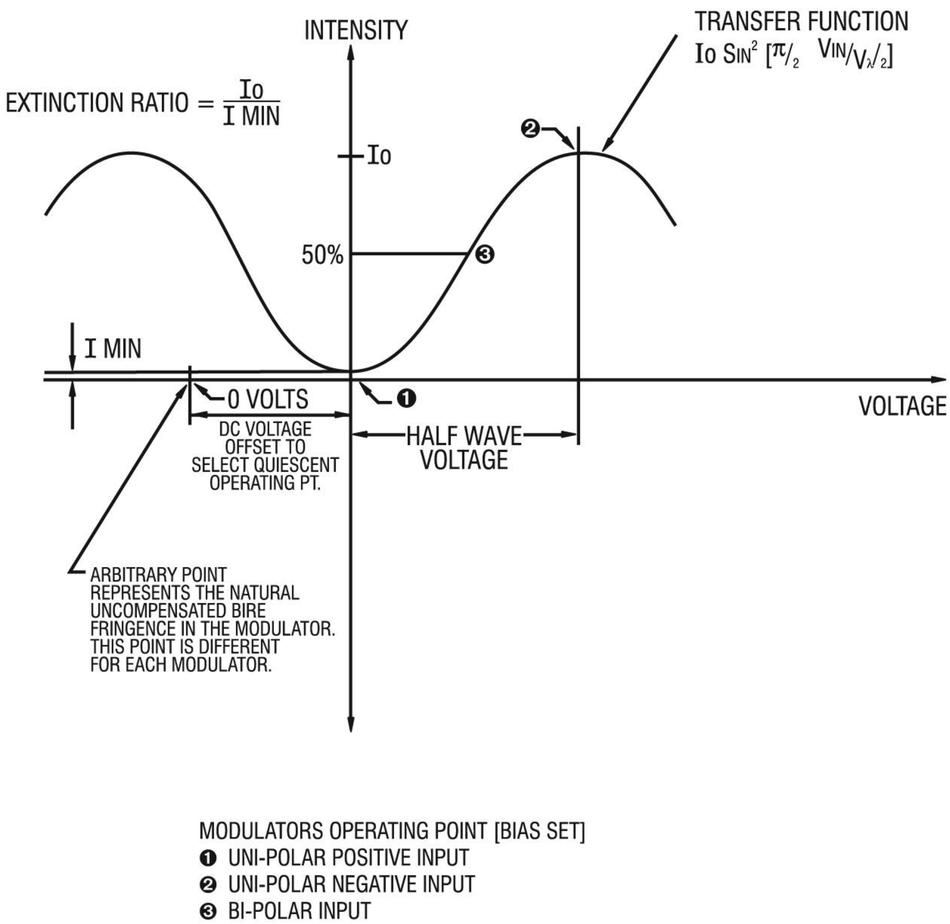
LASS-II-RM Connection Diagram
J5 connects to **J5m** (White Cable, Photodiode) (Photodiode Preamp & Attenuating Polarizer)
J6 to Photodiode amplifier (Gray Cable)
J4 to External Oscilloscope (not pictured)
J3 (P3 label on cable) to **J3m** (P3m - Label)
J2 (P2 label on cable) to **J2m** (P2m – Label)

Modulator Alignment Procedure Parameters

ConOptics modulators are used in variety of applications. The most common use is **Amplitude Modulation**. In this mode the polarizer is aligned to the crystal axis which converts polarization modulation to intensity modulation. The transfer function is Sine squared.

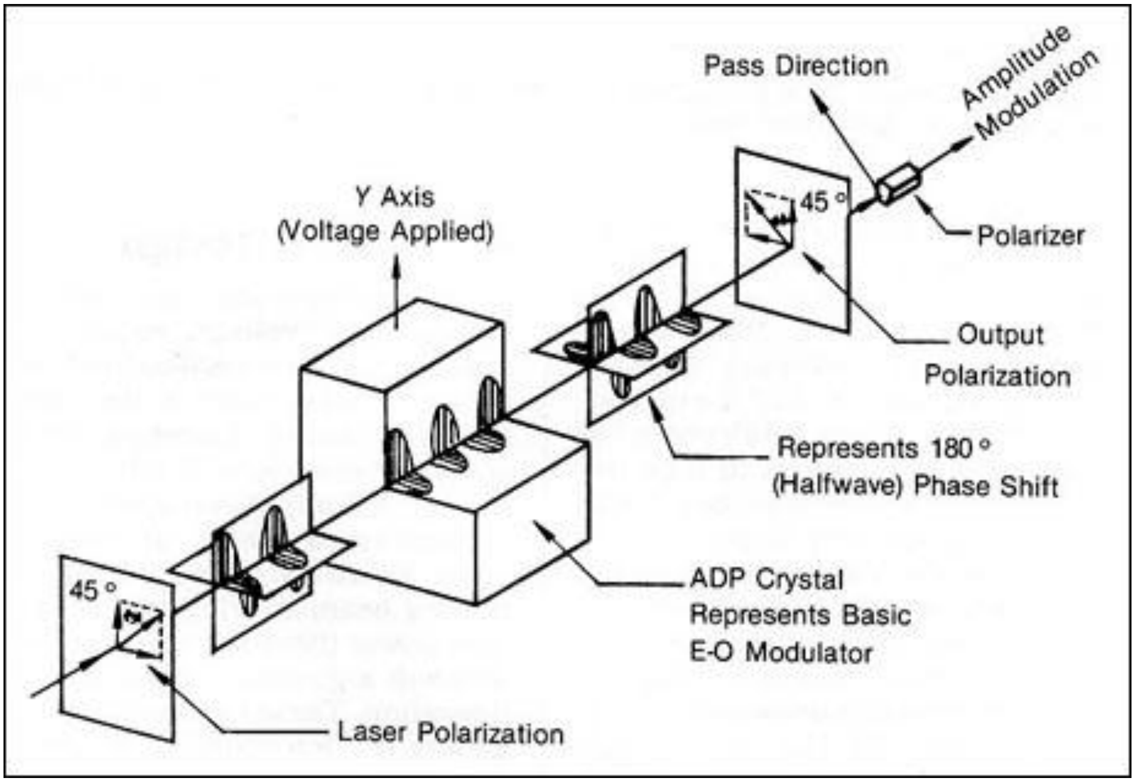
The following diagram (Figure 1) identifies "uni-polar "input signals and bi-polar input signals.

Figure 1



This configuration can also be used as a **Polarization Rotator** or a **Variable Wave Plate**. This is identified during the order process and includes a removable polarizer. In the event that this was not identified during the ordering process, align the modulator with the polarizer facing the laser source, and then simply rotate the complete assembly for maximum transmission. If the application is to include linear polarization rotating in azimuth as a function of the applied voltage a ¼ wave-plate is required (at the lasers wavelength) to the output of the modulator. The diagram (Figure 2) below identifies this process.

Figure 2



Modulator Aperture Size

Laser beams typically do not have sharp edges like the cone of light that passes through the aperture of a lens. Instead, the irradiance falls off gradually away from the center of the beam. It is very common for the beam to have a Gaussian profile (bell-shaped). Laser beam diameters are typically specified at $1/e^2$ irradiance points. If the beam is specified as 1.5 mm at $1/e^2$ points, the diameter at which its irradiance falls to 1% will be 50% larger or 2.25 mm.

ConOptics Modulator apertures are 2.7 mm, 3.1 mm and 3.5mm in diameter. The maximum beam diameter for the 2.7 mm product is 1.8 mm at $1/e^2$ points or 2.4 mm at 1% of maximum points. ConOptics Modulators do not include a hard aperture so overfilling can cause damage to the product. The modulator should be positioned as close as possible to the laser's output. This will minimize the beam growth caused by the laser's natural divergence.

Please note:

1. *Do not overfill the modulator aperture*
2. *Do not block the rejected components on the modulator assembly. Use a stop at least a few cm away*

Modulator Alignment Procedure

The prerequisites for Modulator Alignment are listed below:

- If the modulator is operated between crossed polarizer's, so the output polarization is 90^o to the input polarization, the transmitted laser power will be close to a minimum with 0 volts DC bias
- If the modulator is operated between parallel polarizer's, the transmission will be close to a maximum with 0 volts DC bias. Choose this configuration only if the modulator will be open or at maximum transmission most of the time
- A DC power supply is required. If you have purchased a complete system with driver from ConOptics then the power supply is included

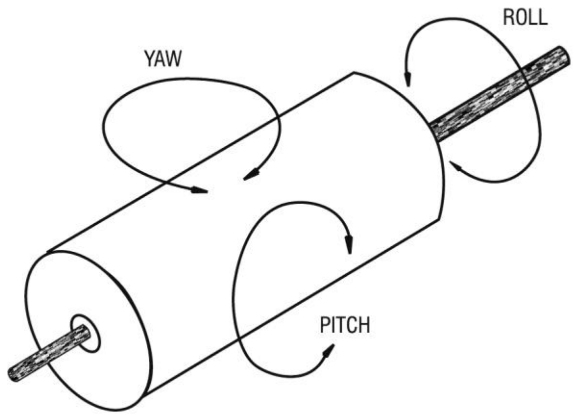
Please note:

The two crystal 350 series (350-50/350-80/350-80LA and 350-105) are close to being zero wave-plates when operated between crossed polarizer's. Since they are close to a null or minimum transmission with no voltage, the bias voltage for a null is relatively low. Maintaining a low DC bias voltage is important to the longevity of the modulator.

Modulator Support

A suitable modulator support must be provided so that roll, pitch and yaw adjustments can be performed as shown in the (Figure 3) below.

Figure 3



ConOptics has developed a modulator mount which makes roll, pitch and yaw adjustments effortless. The image below illustrates our modulator installed in the Model 102 Mount.

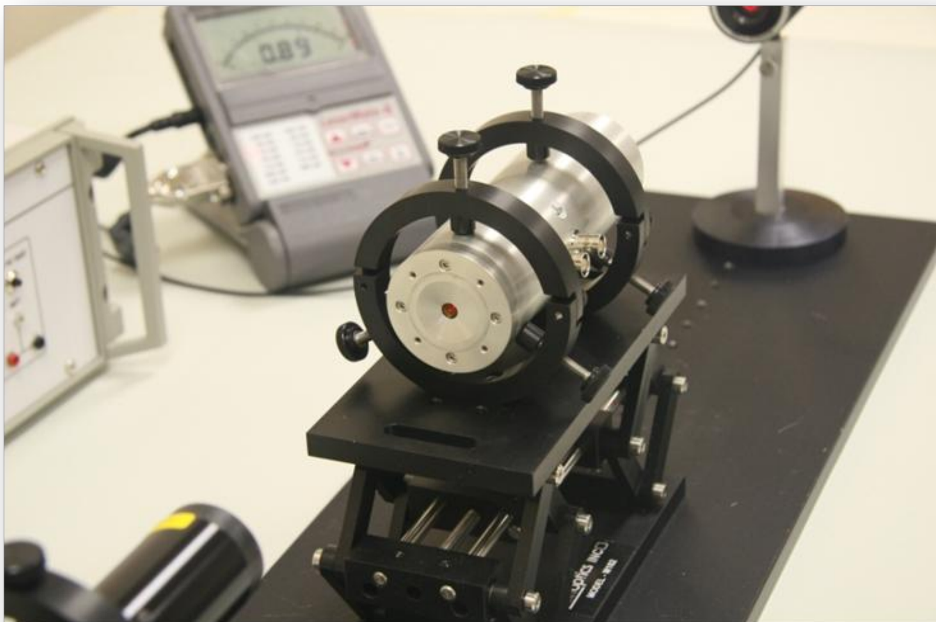
Alignment

Align the modulator such that the beam enters and exits without any beam distortion. This should be done at a power level of less than 200 mw. If you cannot adjust the laser power to this level, use an auxiliary polarizer at the input to lower the power. The Model 103 alignment tool is used to bore sight the laser to the mount. Adjustments can be made using the Model 102 Mount. Coarse adjustments use lab jack for height and for fine adjustment use (4) thumb screw as shown in (Figure 4) for maximum signal.

Figure 4

After obtain the maximum signal from the alignment tool, install the modulator. Be sure the beam exiting the modulator is clear with no vignetting or scatter, illustrated in (Figure 5) below.

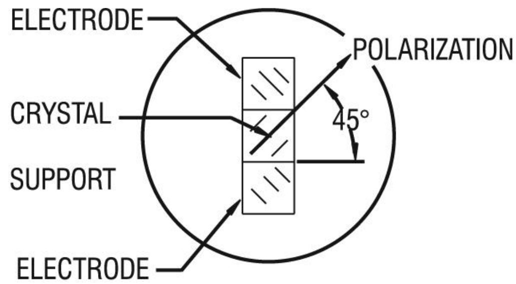
Figure 5



Polarization Alignment

Then rotate the cell about its axis to align the polarization so that it bisects the crystal axis at a 45^{o} angle as shown in the (Figure 6) below.

Figure 6

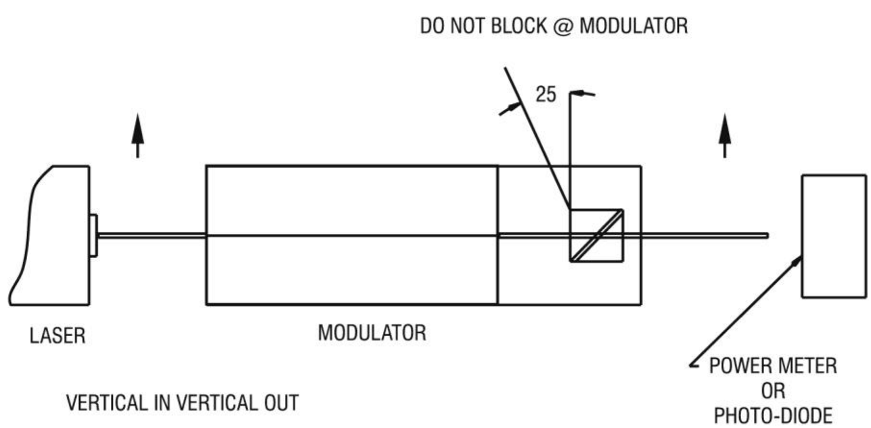


Please note:

If you've used an auxiliary polarizer at the input for power attenuation, it will have to be removed for this step.

If the laser polarization is vertical, and you want the output to be vertical, then the rejected component will be directed to the ceiling or table top. To obtain a horizontal plane of polarization (vertical in), position the rejected component in a plane parallel to the tabletop illustrated in (Figure 7) below.

Figure 7



Please note:

It is very important to avoid blocking the rejected component at the modulator.

Fine polarization adjustment

Fine polarization alignment, is used to ensure the polarization bisects the crystal axis which avoids performance degradation. Align a power meter or photo-diode to accept the beam exiting the modulator. For parallel operation (vertical in-vertical out), adjust the bias voltage and the rotation of the cell for a minimum. For crossed operation, adjust the bias voltage and rotation for a maximum.

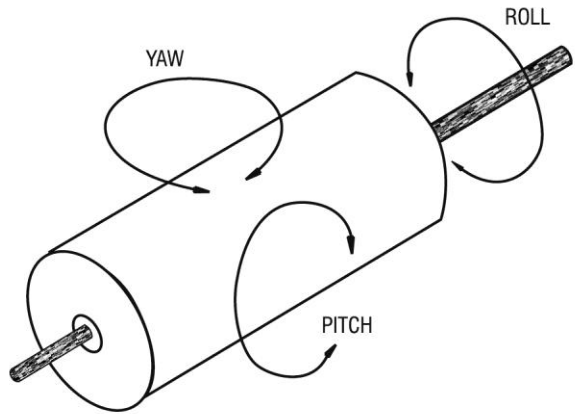
The laser's polarization should be at least 100:1. This means that no more than 1% of the light is polarized in a different plane than the main polarization. Since the modulator is a cylinder there's no need to employ polarization rotation optics prior to the modulator. The use of beam folding optics prior to the modulator should be avoided because these components typically change the polarization purity and angle. If folding optics is employed, an input polarizer should be installed before the modulator.

Fine pitch and yaw adjustment

The fine pitch and yaw adjustment is performed to optimize the extinction ratio, the ratio of maximum to minimum transmission. Adjust the voltage for a maximum and note the extinction ratio. Adjust the voltage for a minimum. Then adjust the cell in pitch and yaw, slightly, while reducing the minimum as possible. You will have to re-adjust the voltage to perform this last step. Re-check the maximum to be sure that you have not reduced it. Repeat if necessary until you have the achieved the highest possible extinction ratio.

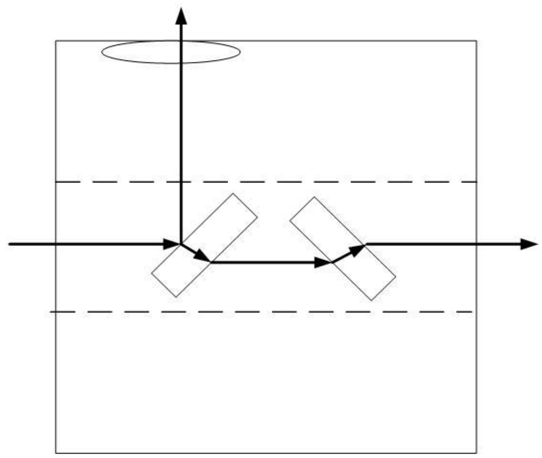
The extinction ratio and transmission measurements should be made with an iris before the detector to eliminate background light. The modulator's operating point is set with the driver's bias supply. This should be done without any signal into the driver's input. The modulator's operating point can be set for bipolar or unipolar input. For positive unipolar input set the modulator for minimum transmission at the lowest DC value. For negative unipolar input set the modulator for maximum transmission. For bipolar input set the modulator at 50% transmission.

A suitable modulator support must be provided so that the adjustments of the modulator can be made in roll, pitch and yaw.



Beam Splitter Calibration

Once the modulator has been aligned to the laser, the Beam Splitter and Photodiode Preamp may be calibrated and the system set in operation.



Beam Splitter Description

The standard beam splitter is composed of two off-setting 6mm thick quartz plates to provide approximately a 1-to-10% (Ipo) sample of the throughput intensity. With the sample aperture aligned to the BNC connectors on the modulator, approximately 1% of the throughput will exit Ipo. At +/- 90° to this position, 10% will exit Ipo. Nominally, when aligned to the 1% position, the beam splitter will be ~96% transmissive. When at 10% position, the beam splitter will be 68% transmissive due to polarization effects of the second surface of the beam splitter itself and the compensating plate. For this reason, care should be taken when rotating the beam splitter not to greatly exceed what is required to calibrate the loop. The Photodiode Preamp assembly contains an attenuating polarizer to provide finesse in the calibration process. As the beam splitter is rotated, the polarization of the light impingement on the attenuating polarizer changes, requiring a rotation of the Preamp assembly to maximize the throughput efficiency.

The following procedure should provide both efficiency and finesse in calibrating the system.

Step 1:	Set the laser input power to desired level
Step 2:	Monitor throughput intensity with appropriate power meter
Step 3:	Monitor PD Test front Panel (PD Test) with IMeg zi oscilloscope
Step 4:	Place Bias Control in Manual, adjust for max transmission.
Step 5:	Loosen Photodiode locking set screw and rotate for max. signal at PD test. (If more than 1.5V decrease beam splitter pick-off by rotation toward parallel to BNC connector on modulator)
Step 6:	With Photodiode assembly adjusted for max output at J4, level should not exceed 1.5V. This insures the beam splitter is adjusted for efficient throughput intensity. (Very high power throughputs, i.e. 2W and up should be done at minimum beam splitter pick-off and rely on attenuating polarizer in Photodiode Amp assembly to attenuate power to detector)
Step 7:	Adjust Diode assembly to obtain +1.0 VDC at PD Test with bias adjusted for max. transmission.
Step 8:	Adjust “Set Point” control on front panel to desired normalized throughput intensity. The loop is completely automatic and should lock at desired level.
Step 9:	The output intensity of the system, closed loop, will be the Set Point reading (i.e. 5.0 = .5 normalized) x the overall maximum static transmission. This includes both modulator and beam splitter transmission at the calibrated input power level.

LASS-II-RM Operating Instructions

There are two basic modes of operation for the LASS II RM, Internal Reference and External Reference. For most applications, the internal mode is used. This mode enables the front panel set-point control, which sets the operating point of the system. After the modulator and beam splitter have been calibrated, the set-point control indicates the normalized throughput intensity. For example, 5.0 on the counting dial should yield 50% of maximum transmission. Certain constraints must be placed on overall operating range due to the non-linear transfer function of the modulator and polarizer combination.

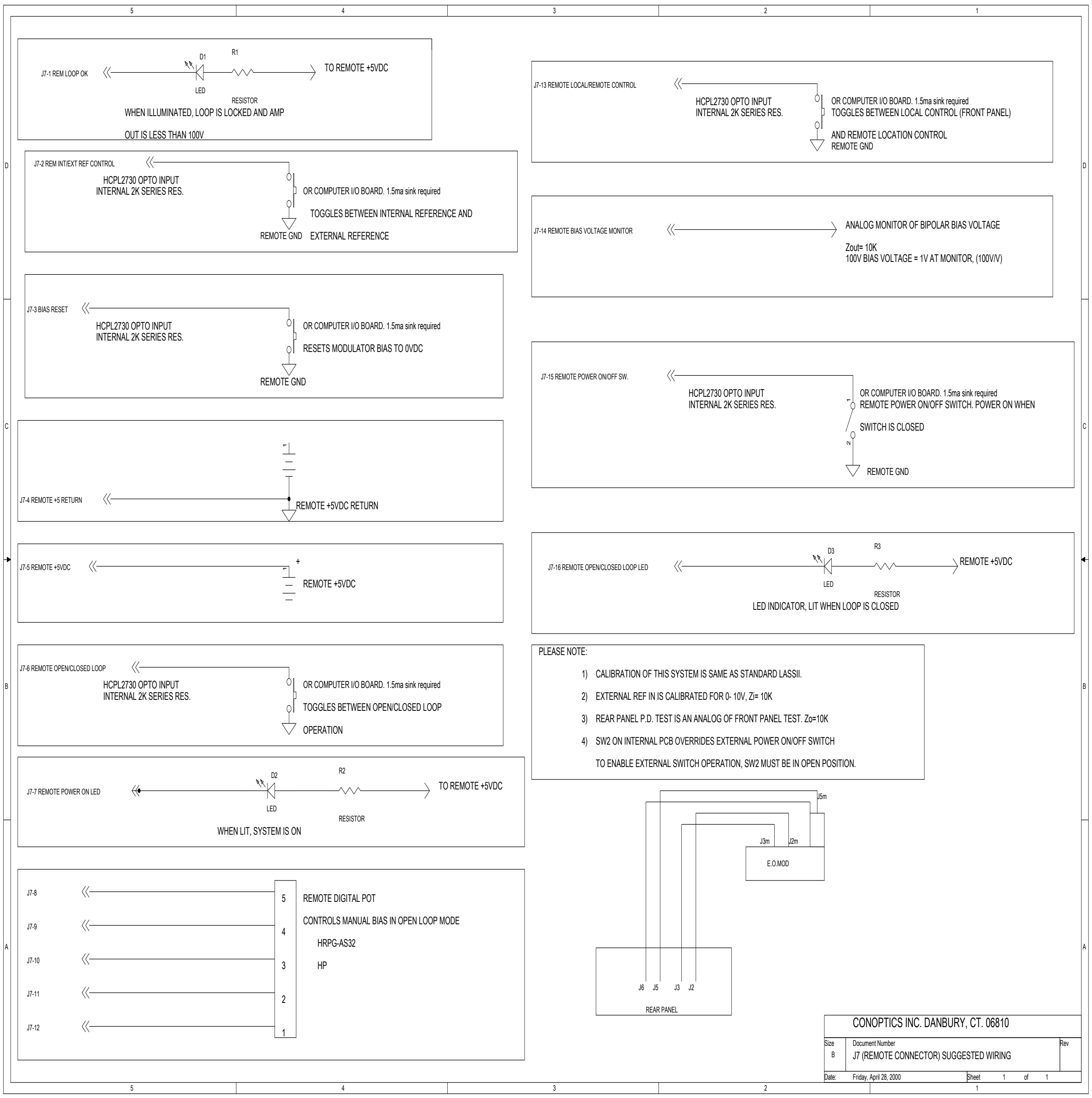
The modulator and polarizer combination has a Sin^2Vi transfer function. This yields rather large changes in the incremental gain slope over it full range. For example, at the top and bottom of this transfer function, the gain slope (dlo/dVi) is equal to zero. As a result, the feedback attenuation increases dramatically and the useable forward gain approaches zero.

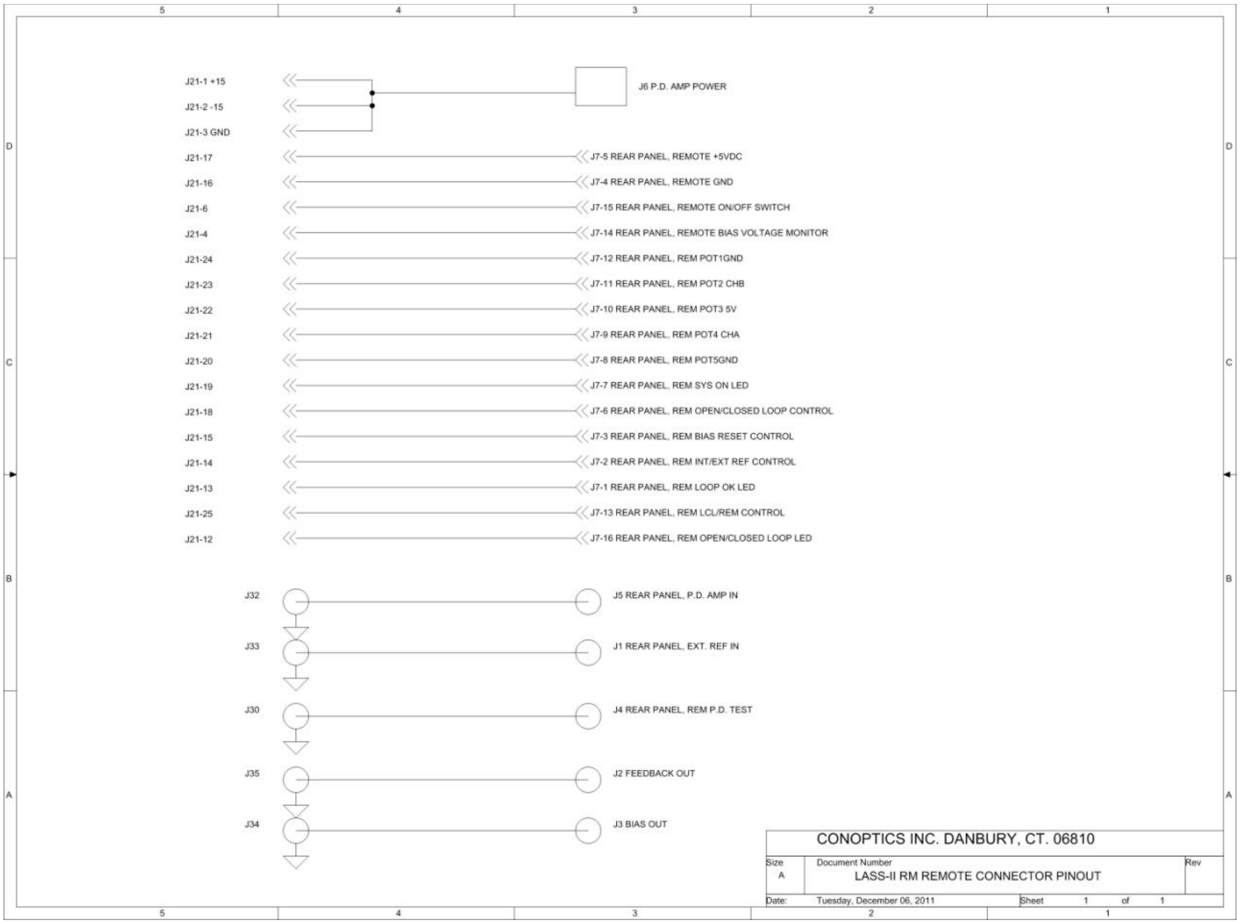
Typical operating points should extend from .15 minimum to .85 maximum. Internally, the ten turn set-point control goes from 0.0V to 1.00V DC (.1V DC/turn). This will yield a linear output power response through the suggested operating range.

In the external mode, the reference is simply shifted to the outside world. This allows remote programming of the throughput intensity and will also yield a linear power output/Vi. Calibration is the same as internal. The signal source must be capable of driving a 10K load.

Appendix

J7 External




J21-1 +15
J21-2 -15
J21-3 GND
J6 P.D. AMP POWER
J21-17
J7-5 REAR PANEL, REMOTE +5VDC
J21-16
J7-4 REAR PANEL, REMOTE GND
J21-6
J7-15 REAR PANEL, REMOTE ON/OFF SWITCH
J21-4
J7-14 REAR PANEL, REMOTE BIAS VOLTAGE MONITOR
J21-24
J7-12 REAR PANEL, REM POT1GND
J21-23
J7-11 REAR PANEL, REM POT2 CHB
J21-22
J7-10 REAR PANEL, REM POT3 5V
J21-21
J7-9 REAR PANEL, REM POT4 CHA
J21-20
J7-8 REAR PANEL, REM POT5GND
J21-19
J7-7 REAR PANEL, REM SYS ON LED
J21-18
J7-6 REAR PANEL, REM OPEN/CLOSED LOOP CONTROL
J21-15
J7-3 REAR PANEL, REM BIAS RESET CONTROL
J21-14
J7-2 REAR PANEL, REM INT/EXT REF CONTROL
J21-13
J7-1 REAR PANEL, REM LOOP OK LED
J21-25
J7-13 REAR PANEL, REM LCL/REM CONTROL
J21-12
J7-16 REAR PANEL, REM OPEN/CLOSED LOOP LED
J32
J5 REAR PANEL, P.D. AMP IN
J33
J1 REAR PANEL, EXT. REF IN
J30
J4 REAR PANEL, REM P.D. TEST
J35
J2 FEEDBACK OUT
J34
J3 BIAS OUT
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Date: Tuesday, December 06, 2011
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